Proposed Revisions to Connecticut's Volatilization Criteria

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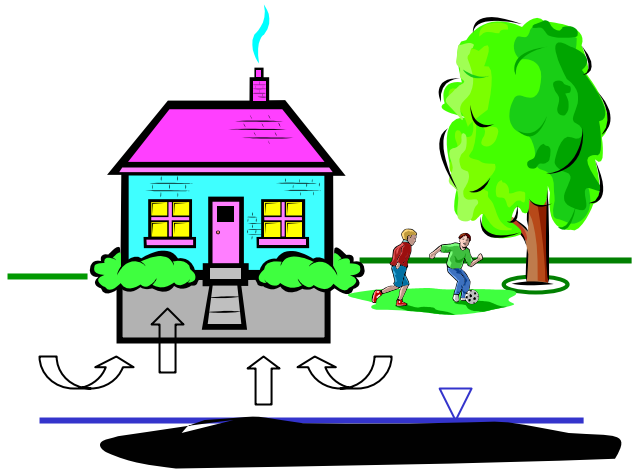
Today's Presentation

- Revisions to Volatilization Criteria
  - What are volatilization criteria?
    - How were they developed?
      - What are we changing?
- Revised Transport Model
  - Ruth Parks, CTDEP
- Target Indoor Air Concentrations
  - Dr. Gary Ginsberg, CTDPH
- Application of Volatilization Criteria
- Summary
- Timeline for Finalizing Proposed Revisions
- Questions?

What are Volatilization Criteria?

It has been shown that subsurface contaminants can volatilize and move upward and into overlying structures.

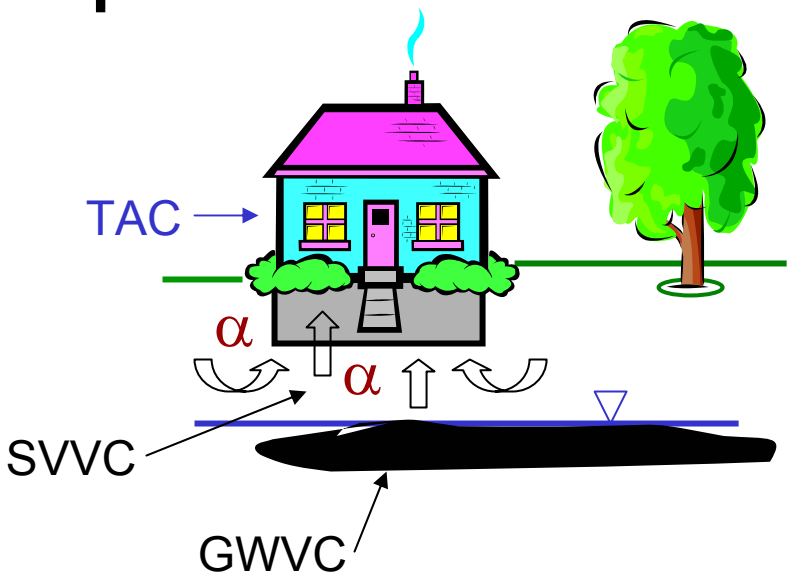


Volatilization criteria are acceptable limits of contamination in groundwater and soil vapor that will not cause adverse impacts on occupants of these buildings.

How are the Volatilization Criteria developed?

Protective target indoor air concentrations (TACs) are developed.

Attenuation factor (α) is calculated by using the transport model.



Finally, allowable levels of contamination in groundwater and soil vapor are calculated based on TAC and α:

SVVC (mg/m^3) = TAC ($\mu g/m^3$) / (1000 $\mu g/mg$ x α)

GWVC (ug/L) = TAC ($\mu g/m^3$) / (1000 L/m^3 x α x H)

Reasons for Revising the Volatilization Criteria

- Toxicity information is outdated
- Original Johnson and Ettinger model used under-predicts indoor air concentrations
  - Investigations at sites in CT and across the country shows this
- Revised Johnson and Ettinger model used by EPA in their latest guidance, as well as by other states, including MA, MI, PA, and CA.
- Revisions will be part of State's application for RCRA Corrective Action authorization

What changes are proposed?

Basis for 1996 RSR Vol. Criteria	Proposed Revisions to Criteria
•J & E transport model with **diffusion** as sole transport mechanism (from 1994 ASTM)	•Use revised J & E transport model with **diffusion and advection** as transport mechanisms
•TACs based on **1995** toxicity values	•Revise TACs based on **updated** toxicity values
•Inhalation rate exposure assumptions for TACs **same** for both residential and ind/comm scenarios	•**Reduce** inhalation rate for ind/comm scenario by ½ to reflect shorter exposure time

What changes are proposed?

Basis for 1996 RSR Vol. Criteria

- Residential TAC based on carcinogenic risk calculated for **adult** exposure
- **1995** information for typical or high end background indoor air used as basis for TAC
- Analytical detection limits based on **1995** analytical methods
- Volatilization criteria applied to groundwater within **15 feet** of surface

Proposed Revisions to Criteria

- Recalculate residential TACs based on **children's** greater exposure and cancer sensitivity
- **Updated** information for typical background indoor air used as basis for TAC
- Analytical detection limits based on **current** analytical methods
- Volatilization criteria applied to groundwater within **30 feet** of surface

Proposed Changes to Transport Model

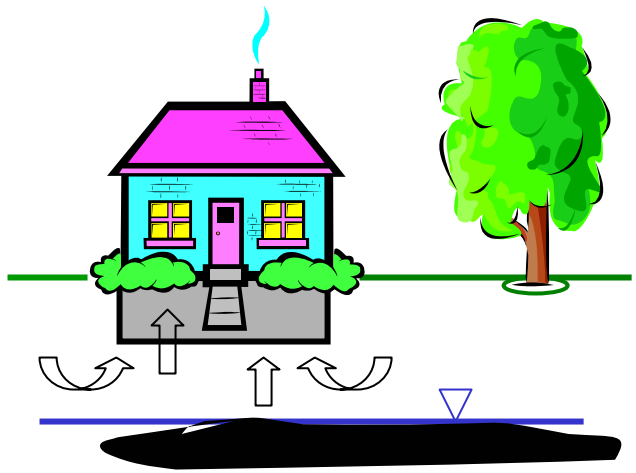
Ruth Parks, CTDEP

Revised Johnson and Ettinger Model

A revised version of the model used in 1996 that now incorporates two transport mechanisms.

Diffusion:

Mechanism by which vapor moves from a region of higher concentration to a region of lower concentration. Typically the vertical component of transport in this model.



Advection:

Mechanism by which vapor moves to a region where there is a difference in atmospheric properties, such as pressure or temperature.

Model Assumptions

J & E Model makes the following assumptions:

- Steady state conditions exist
- An infinite source of contamination exists
- The subsurface is homogeneous
- Mixing in the building is uniform
- No preferential pathways exist
- Biodegradation (or any other transformation process) does not occur

Attenuation Factor

The J & E Model results in an attenuation factor, α.

The **attenuation factor** is the ratio of the indoor air concentration to the concentration in the subsurface.

$$\alpha = \text{Concentration}_{\text{indoor air}} / \text{Concentration}_{\text{subsurface}}$$

or

$$\alpha = \text{TAC} / \text{SVVC}$$

J & E model calculates α using the following equations which require site specific input values.

Revised J & E Model

$$\alpha = (A \times e^{B}) / [e^{B} + A + (A/C)(e^{B}-1)]$$

where:

$A = (D^{eff}_{T}) / (E_B(V_B/A_B)L_T)$ or $(D^{eff}_{T} A_B) / (Q_B L_T)$

$B = [(Q_{soil}/Q_b)E_B(V_B/A_B)L_{crack}] / [D^{eff}_{crack}\eta]$ or $(Q_{soil}L_{crack}) / (D^{eff}_{crack}\eta A_B)$

$C = Q_{soil}/Q_B$

where:

$D^{eff}_{T} = L_T / [(L_{vadose}/D^{eff}_{vadose}) + (L_{cap}/D^{eff}_{cap})$

$D^{eff}_{crack} = D^{air}(\theta_{V\text{-}crack}^{3.33}/\theta_{T\text{-}crack}^{2}) + (D^{water}/H)(\theta_{m\text{-}crack}^{3.33}/\theta_{T\text{-}crack}^{2})$

where:

$D^{eff}_{vadose} = D^{air}(\theta_{V\text{-}vadose}^{3.33}/\theta_{T\text{-}vadose}^{2}) + (D^{water}/H)(\theta_{m\text{-}vadose}^{3.33}/\theta_{T\text{-}vadose}^{2})$

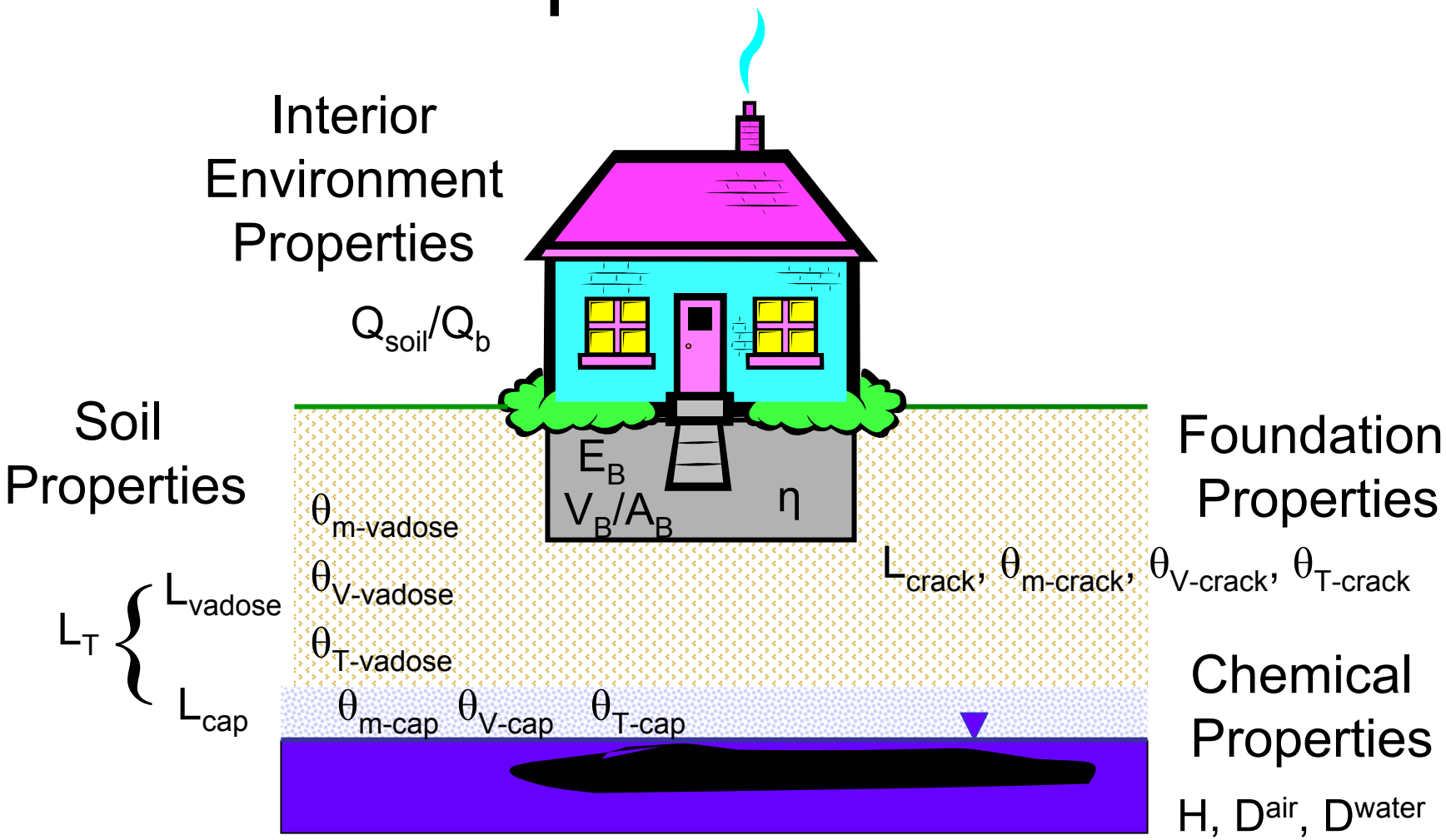
$D^{eff}_{cap} = D^{air}(\theta_{V\text{-}cap}^{3.33}/\theta_{T\text{-}cap}^{2}) + (D^{water}/H)(\theta_{m\text{-}cap}^{3.33}/\theta_{T\text{-}cap}^{2})$

What really matters are the **input values**

Input values describe the vapor transport pathway:

- subsurface soils and stratigraphy
- foundation of the structure
- interior environment of the structure
- transport properties of the contaminants

Input Values



Critical Input Values

The more critical or sensitive input values are:

- the **depth** to groundwater or the depth to soil vapor sample ($\mathbf{L_T}$)
  - CT uses $\mathbf{L_T}$= 3 meters to GW & $\mathbf{L_T}$= 1 meter to SV
- the **thickness of capillary fringe** ($\mathbf{L_{cap}}$) which is controlled by the soil type
  - CT uses $\mathbf{L_{cap}}$= 5 cm based on properties of sand
- and depending on the **dominant mechanism** of transport (diffusion or advection) certain input values become more critical or less critical.

For additional information:

"Identification of Critical Parameters for the Johnson and Ettinger (1991)Vapor Intrusion Model" by Johnson. API Bulletin No. 17, May 2002.

Sources of Default Input Values

- All of the default values are the same values used in 1996, with the exception of Q_{soil}/Q_B.
  - Q_{soil}/Q_B was not part of model used in 1996.
  - Default value for Q_{soil}/Q_B same as default value used by USEPA in Guidance (2002).
- All other default values from ASTM 38-94.
- Default input values for soil properties based on the assumption of a sand material in the subsurface.

Resulting Attenuation Factor

Using default input values and the new model, the attenuation factor changes as follows:

- For GW Vol. Criteria, α **increases by a factor of ~ 2.5**, from 8×10^{-5} to 2×10^{-4} for residential and from 3×10^{-5} to 7×10^{-5} for ind/comm.
- For SV Vol. Criteria, α **increases by a factor of ~ 10**, from 1.5×10^{-4} to 1.3×10^{-3} for residential and from 6×10^{-5} to 7×10^{-4} for ind/com

As α increases, criteria decrease or become more conservative.

Proposed Changes to Target Indoor Air Concentrations

Dr. Gary Ginsberg, CTDPH

Toxicity Values for TACs

- Data sources:
  - EPA/IRIS, EPA/HEAST, ATSDR MRL, CAL REL, DPH Risk Assessment
- Risk targets:
  - 1 in a million cancer risk or
  - RfC (Reference Concentration) for non-cancer
- "Group C" carcinogens:
  - 3.33 to 10x UF (Uncertainty Factor) applied to RfC
- TACs developed for 13 additional VOCs

Toxicity Values for TACs
(continued)

- Major changes in toxicity values since 1996
  - Vinyl chloride cancer unit risk decreased 10x
  - 1,1-DCE not regulated as low dose carcinogen
  - Styrene not regulated as low dose carcinogen
  - TCE cancer unit risk increased >10 fold
  - 1,4-DCB cancer potency factor developed
  - Ethylbenzene a possible carcinogen

Exposure Assumptions

- Base residential scenario - no changes
  - adult exposure for 350 d/yr x 30 yrs
- Industrial/Commercial scenario
  - 250 d/yr x 25 yrs
  - inhaled air at work - 10 m^3/d
    - 1996 criteria - 20m^3/d
  - Non-cancer TAC: RfC * 2.92
  - Cancer TAC: Conc. for 1 in 10^6 * 8.176

Residential Scenario: Children

- Inhale more air per body weight than adults
  - 2 times greater dose over 6 years
- Generally susceptible period
  - immature systems and rapid growth
- Carcinogens: ↑ed potency in young rodents
  - genotoxic carcinogens
  - high rate of cell division - ↑ed risk for mutation
  - longer period for cancer development

Residential Scenario: Children

(continued)

- Including children's cancer risk in TACs
  - early life risk = risk from later in life
  - add across age groups --> double the unit risk
  - EPA/IRIS for vinyl chloride
  - DPH: other carcinogens (Ginsberg, 2003)
  - Draft Cancer RA Guidelines (EPA, 2003)
- Overall children's risk factors:
  - 2x for increased exposure; 2x for cancer risk

TAC Derivation: Background

- Potent toxicants with low TACs
  - may be below background
- Expanding indoor air background database
- Median/average background conc. selected
- Background key factor for:
  - Benzene, 1,4-DCB, PERC, Methylene chloride, 1,1,2-TCA, TCE

TAC Derivation: Ceiling

- Certain VOCs - risk-based TAC high
- Potential to degrade air quality
- Ceiling TAC for residential and I/C
  - 500 ug/m^3
  - level of clear Indoor Air Quality (IAQ) contamination that may cause non-specific symptoms
- Odor threshold lower than ceiling in some cases

Presentation of TACs – Appendix B

Target Air Concentrations (TACs) for Residential Scenario

(Page 1)

VOC	Toxicity Value[1]	Modifying Factors[2]	Risk-Based TAC[4]	Background	TAC
Acetone	IRIS RfD (0.1mg-kg-d) converted to RfC (350 ug/m^3)	2x CexpF	183 ug/m^3	---[7]	180 ug/m^3
Benzene	IRIS unit risk (8.3E-6/ug/m^3)	2x CexpF; 2x CsensF	0.07 ug/m^3	3.25 ug/m^3	3.25 ug/m^3
Bromoform	IRIS unit risk (1.1E-6/ug/m^3)	2x CexpF; 2x CsensF	0.55 ug/m^3	Not available	0.55 ug/m^3
2-Butanone (MEK)	IRIS RfC (1000 ug/m^3)	2x CexpF	520 ug/m^3	---[7]	500 ug/m^3 – C[3]
Carbon Tetrachloride	IRIS unit risk (1.5E-5/ug/m^3)	2x CexpF; 2x CsensF	0.04 ug/m^3	0.5 ug/m3	0.5 ug/m^3
Chlorobenzene	IRIS RfD (0.02 mg-kg-d) converted to RfC (70 ug/m^3)	2x CexpF	36 ug/m^3	---[7]	36 ug/m^3
Chloroform	IRIS unit risk (2.3E-5/ug/m^3)	2x CexpF	0.05 ug/m^3	0.5 ug/m^3	0.5 ug/m^3

Proposed Changes to Application of Volatilization Criteria

Elsie Patton, CTDEP

Applicability

- In the current regulations the volatilization criteria apply to polluted ground water within **15 feet** of the ground surface or a building.
- However, unacceptable indoor air concentrations can result from a ground water source significantly deeper than 15 feet.
- EPA guidance applies to ground water within **100 feet** of a building.
- DEP proposes to revise applicable depth to **30 feet.**

In Summary

- Revised transport model
- Toxicity values revised

  significant revisions to toxicity value for 1,1 DCE which in the past has been a driver for remediation at many sites.
- I/C exposure assumptions revised
- Children are taken into consideration for residential exposure
- Lower detection limits achievable
- Applying the criteria to a depth of 30 feet

What does this mean to you?

- The proposed revised criteria should be considered as you move forward with current remediation projects.
- In general, DEP will not revisit completed projects unless the site is subject to a new remediation requirement.
- However, we may revisit completed projects where high concentrations of volatiles are present in ground water at depths between 15 feet and 30 feet from the surface.

What does this mean to you?
(continued)

- You should continue to do additional evaluation where site specific conditions may indicate a potential risk to human health even though criteria are met such as:
  - Polluted ground water is very close or even in the basement of a building, or
  - There is clearly a preferential pathway

Timeline for Finalizing the Proposed Revisions to the Volatilization Criteria

- March 20, 2003 to June 30, 2003 – DEP will seek public comments on proposal
- July 2003 – Regulations Adoption Process begins with proposed draft regs for public comment.

Comments

Comments regarding these proposed revisions can be sent to:

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or
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before **June 30, 2003**

Questions?